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Genitalia of the Membracidae of Wisconsin

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Only recently has serious taxonomic study of the genitalia of Membracidae been undertaken. Authors such as Fowler (1894-97), Van Duzee (1908), Funkhouser (1917) and Lawson (1922) made only cursory studies or objected to the dissection and treatment necessary for such a study. Caldwell's (1949) revision of the Ceresini based on male genitalia is the first paper of its kind for the Membracidae.

The male and female genitalia of 74 species known to occur in Wisconsin have been studied to determine their taxonomic usefulness. The entire abdomen was removed and treated with 10 per cent potassium hydroxide solution until the soft parts were removed. Care should be exercised to prevent depigmentation of sclerotized parts. The abdomen was then washed and stored in a small amount of glycerine in a corked 4 x 10 mm. vial on the pin with the insect. Dissections were made on a spot plate under glycerine. The structures of the genitalia for both sexes are illustrated in Plate 1, Figs. 1 and 2. The teeth of valvula 2 of the female are numbered from the most basal one distally.

Acknowledgments

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Subfamily Membracinae (Stal)
Campylenchia latipes (Say)

Male

Lateral valves without teeth. Subgenital plate (Plate II, Fig. 2) of two distinct sclerites: the basal sclerite small, transverse, widest at base; the distal sclerite elongate, its basal margin with a wide median notch, narrowest at basal ⅓, longitudinally split for ⅔ its length from distal margin. Styles (Plate I, Fig. 4) with anterior and posterior arms separate as two sclerites: anterior arms simple; posterior arms curved upward, divergent, ending in a double-pointed tip with the terminal tooth longer and more slender than the anterior one; a dorso-lateral row of small hairs present on apical ⅓ to ½. Connective (Plate II, Fig. 33) with two anterior lobes; constricted in basal ⅓; widest in posterior ⅔; posterior margin obtuse. Aedeagus (Plate III, Fig. 1) with anterior arm having an anterior and a superior lobe which vary in shape; posterior arm with anterior face having a long median groove with fine teeth dorsal and lateral to it; posterior arm in posterior aspect elliptical, broadly constricted above the middle; functional orifice elliptical, in dorsal ⅓ of posterior face of posterior arm.

Female

Sternite VII (Plate IV, Fig. 1) with posterior margin entirely a broad, round-bottomed notch with slightly sinuate sides reaching 11/16 of the depth

of the segment. Valvulae 1 narrowed to the bluntly rounded tip, which is sinuate below. Valvula 2 (Plate IV, Fig. 23) with two large teeth and dorsally finely serrate from tooth 2 to tip. Valvulae 3 broadened in posterior ½.

Enchenopa binotata (Say)

Male

Lateral valves without teeth. Subgenital plate (Plate II, Fig. 1) of two distinct sclerites: the basal sclerite small, transverse, widest at base; the distal sclerite elongate, its basal margin with a small median notch, widest in distal ⅓, longitudinally split for ⅘ its length from distal margin. Styles (Plate I, Fig. 3) like those of *C. latipes* but with terminal tooth smaller. Connective like that of *C. latipes*. Aedeagus (Plate III, Fig. 2) like that of *C. latipes* but with lobes of anterior arm less variable and posterior arm more slender and with sides almost parallel in posterior aspect.

Female

Indistinguishable from *C. latipes*.

Subfamily Centrotinae (Spinola)
Microcentrus caryae (Fitch)

Male

Lateral valve (Plate II, Fig. 19) with a large blunt tooth directed ventromedially from dorsal margin. Subgenital plate (Plate II, Fig. 3) constricted at basal ¼, narrowest at apical ⅔, longitudinally split for ½ its length from distal margin. Styles (Plate I, Fig. 5) with anterior arms reduced; posterior arms upturned, convergent, blunt, each with a blunt, flattened, latero-dorsal, strongly recurved tooth; inner margin of apical ⅗ of style and apex with a row of small hairs. Connective (Plate II, Fig. 34) with anterior margin truncate; roundly widening to widest point in basal ¼; posterior ⅔ quadrate. Aedeagus (Plate III, Fig. 3) with anterior arm reduced; posterior arm slender, anterior face of posterior arm with fine teeth in apical ⅘; functional orifice on the declivity from apex to posterior face of posterior arm.

Female

Sternite VII (Plate IV, Fig. 2) with broad round-bottomed notch in posterior margin; notch ⅓ the width and ⅔ the depth of the segment. Valvulae 1 bluntly

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Plate I

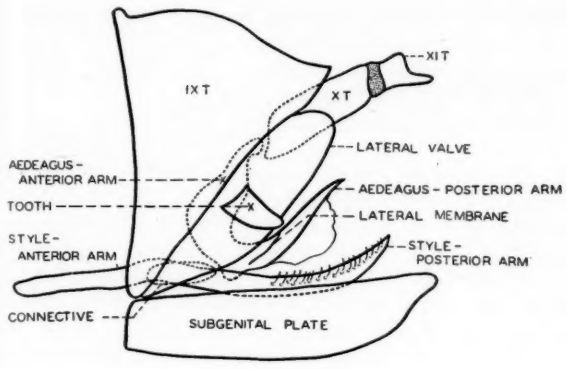
Genitalia of Membracidae

FIG.

1. Male genitalia. Left lateral aspect.
2. Female genitalia. Left lateral aspect, with valves separated.

Figs. 3-26. Styles. All are drawn to the same scale except 6, 7, 12 and 13 which are twice the scale of the others. Figs. 3, 4 and 5 show complete styles; Figs. 6-26 show posterior arms.

3. *Enchenopa binotata*, left, lateral
4. *Campylenchia latipes*, left, lateral
5. *Microcentrus caryae*, left, lateral
6. *Entylia bactriana*, left, lateral
7. *Pubilia concava*, left, lateral
8. *Vanduzea arquata*, left, lateral
9. *Vanduzea triguttata*, left, lateral
10. Smiliini, general type, left, lateral
11. Telamonini, general type, left, lateral
12. *Acutalis tartarea*, left, lateral
13. *Micrutalis calva*, left, lateral
14. *Spissistilus borealis*, left, lateral
15. *Stictocephala albescens*, left, ventro-lateral
16. *Stictocephala diceros*, right, dorsal
17. *Stictocephala lutea*, right, dorsal
18. *Stictocephala bubalus*, right, dorsal
19. *Stictocephala taurina*, right, dorsal
20. *Stictocephala palmeri*, right, dorsal
21. *Stictocephala taurinaformis*, right, dorsal
22. *Stictocephala constans*, right, dorsal
23. *Stictocephala basalis*, right, dorsal
24. *Stictocephala brevitylus dolichotylus*, right, dorsal
25. *Tortistilus inermis*, right, dorsal
26. *Tortistilus curvata*, right, dorsal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XIT
LATERAL VALVE
AEDEAGUS - ANTERIOR ARM
AEDEAGUS - POSTERIOR ARM
TOOTH
LATERAL MEMBRANE
STYLE - ANTERIOR ARM
STYLE - POSTERIOR ARM
CONNECTIVE
SUBGENITAL PLATE

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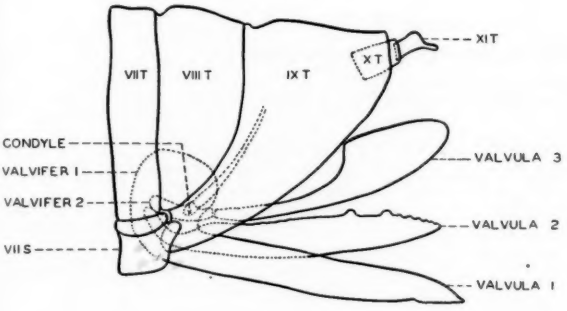
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VALVULA 3
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VALVULA 1

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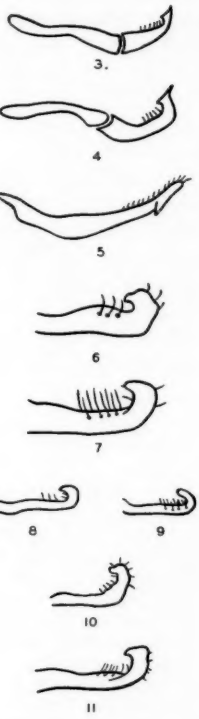
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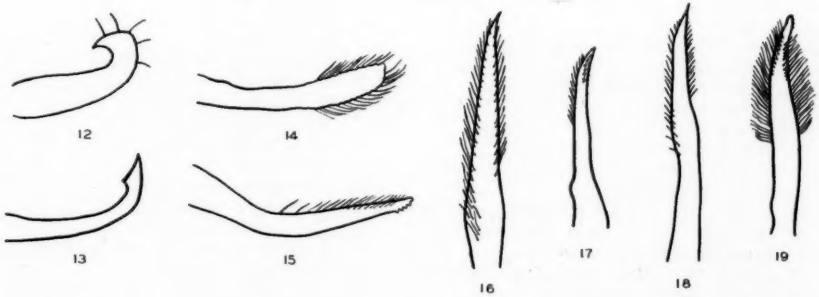
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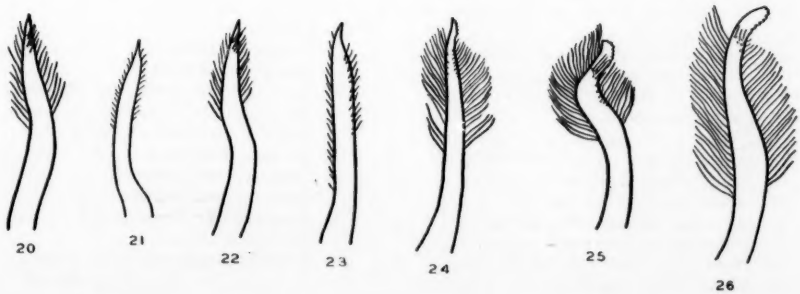
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pointed. Valvula 2 (Plate IV, Fig. 24) dorsally finely serrate in posterior 7/16, perceptibly narrowed basad from serration. Valvulae 3 broadened in posterior 7/16.

Subfamily Smiliinae (Stal)
Tribe Polyglyptini Goding
***Entylia bactriana* Germar**

Male

Lateral valve (Plate II, Fig. 16) without teeth, usually fused to tergite IX in ventral ⅓, rarely more separate. Subgenital plate (Plate II, Fig. 4) basally broad, widest about middle, narrow at tip, longitudinally split from distal margin ¼ the depth of the segment. Styles (Plate I, Fig. 6) with anterior arms variable; posterior arms with tips divergent, recurved and blunt with some variation in recurved part; posterior arms with a few lateral hairs in distal ⅓ and a dorsal row of three hairs on the recurved tips. Connective (Plate II, Fig. 35) with anterior margin incurved; widest below the middle; tapering to the truncate

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Plate II

Male Genitalia of Membracidae

All are drawn to the same scale except 3, 8, 9, 10, 11, 12 and 15 which are 2/5 and 52 which is twice the scale of the others.

FIG.

Figs. 1-15 Subgenital plates. Ventral aspect. Posterior margin at the top.

1. *Enchenopa binotata*
2. *Campylenchia latipes*
3. *Microcentrus caryae*
4. *Entylia bactriana*
5. *Publia concava*
6. *Vanduzea arquata*
7. *Vanduzea triguttata*
8. *Cyrtolobus* and *Xantholobus*, general type
9. *Ophiderma*, general type
10. *Smilia camelus*
11. Telamonini, general type
12. *Thelia bimaculata*
13. *Micrutalis calva*
14. *Acutalis tartarea*
15. *Stictocephala*, *Tortistilus* and *Spissistilus borealis*, general type
16. Tergite IX and lateral valve, *Entylia bactriana* and *Publia concava*. Left lateral aspect of general type.
17. Tergite IX, *Vanduzea arquata*, left lateral aspect. A-oblique transverse carina
18. Tergite IX, *Vanduzea triguttata*, left lateral aspect.
19. Left lateral valve, with tooth, *Microcentrus caryae*

Figs. 20-32 Tooth of lateral valve

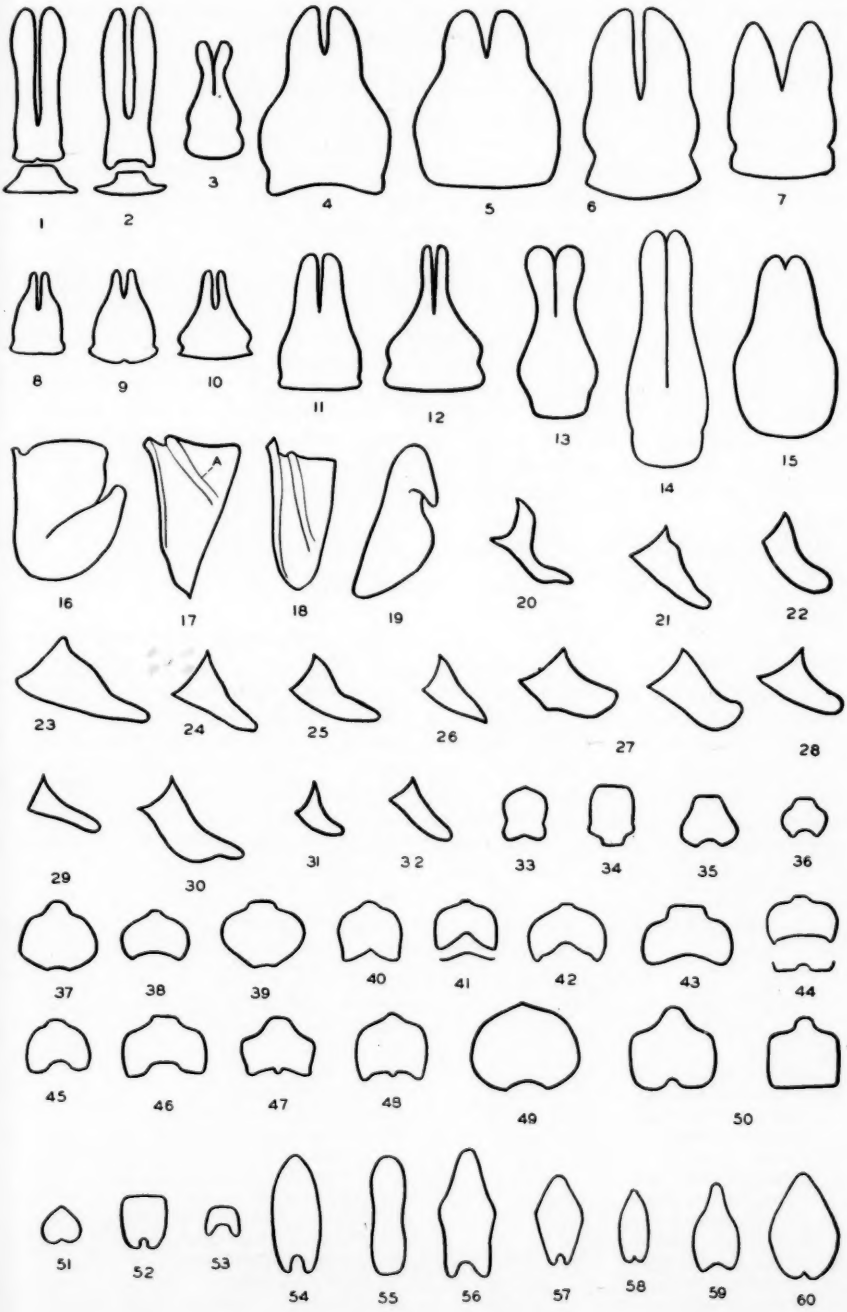
20. *Spissistilus borealis*
21. *Stictocephala basalis*
22. *Stictocephala brevitylus dolichotylus*
23. *Stictocephala diceros*
24. *Stictocephala albescens*
25. *Stictocephala palmeri*
26. *Stictocephala constans*
27. *Stictocephala taurina*
28. *Stictocephala bubalus*

FIG.

29. *Stictocephala lutea*
30. *Stictocephala taurinaformis*
31. *Tortistilus inermis*
32. *Tortistilus curvata*

Figs. 33-60 Connectives. Posterior margin at the top.

33. *Campylenchia latipes* and *Enchenopa binotata*
34. *Microcentrus caryae*
35. *Entylia bactriana*
36. *Pubilia concava*
37. *Smilia camelus*
38. *Cyrtolobus*, general type
39. *Cyrtolobus tuberosus*
40. *Cyrtolobus griseus*
41. *Ophiderma definita*
42. *Ophiderma evelyna*
43. *Ophiderma flava*
44. *Ophiderma grisea*
45. *Ophiderma pubescens*
46. *Ophiderma salamandra*
47. *Xantholobus lateralis* and X. *intermedius*
48. *Xantholobus muticus*
49. Telamonini, general type
50. *Thelia bimaculata*
51. *Acutalis tartarea*
52. *Micrutalis calva*
53. *Spissistilus borealis*
54. *Stictocephala albescens*, *S. basalis*, *S. brevitylus dolichotylus*, *S. bubalus*, *S. constans*, *S. diceros*, general type
55. *Stictocephala lutea*
56. *Stictocephala taurina*
57. *Stictocephala palmeri*
58. *Stictocephala taurinaformis*
59. *Tortistilus inermis*
60. *Tortistilus curvata*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posterior margin. Aedeagus (Plate III, Fig. 4) with anterior arm slender, with a notch on the anterior face at the base; posterior arm with a pair of lateral superior lobes; functional orifice between superior lobes.

Female

Sternite VII (Plate IV, Fig. 3) with a narrow transverse sclerite tightly fused to its base; posterior margin entirely a broad, round-bottomed notch reaching ⅔ the depth of the segment. Valvulae 1 with tips acute. Valvula 2 (Plate IV, Fig. 25) broad, dorsally finely and irregularly serrate in posterior 17/32. Valvulae 3 broadened in posterior ½.

Pubilia concava (Say)

Male

Lateral valves and tergite IX as in *E. bactriana.* Subgenital plate (Plate II, Fig. 5) similar to that of *E. bactriana.* Styles (Plate I, Fig. 7) with anterior arms variable; posterior arms with tips divergent, recurved and blunt; posterior arms with a few dorso-lateral hairs in distal ½ and on the tip. Connective (Plate II, Fig. 36) with anterior margin incurved; widest at the middle; tapering to truncate posterior margin. Aedeagus (Plate III, Fig. 5) with anterior arm with a pair of anterior lobes and often with a small posterior lobe; posterior arm with a pair of large, sharp, lateral teeth near apex; functional orifice round, situated on the declivity from apex to posterior face of posterior arm.

Female

Indistinguishable from *E. bactriana.*

Vanduzea arquata (Say)

Male

Tergite IX (Plate II, Fig. 17) with an oblique transverse carina reaching to just above the middle of the posterior margin. Subgenital plate (Plate II, Fig. 6) constricted at basal 1/6, widest at basal ⅓, narrowing to the rounded tip, longitudinally split from distal margin ½ its length. Styles (Plate I, Fig. 8) with posterior arms recurved, divergent, apices bluntly pointed; posterior arms with a few dorso-lateral hairs in distal ⅓. Connective with anterior margin incurved; broadly rounded to the rounded posterior margin. Aedeagus (Plate III, Fig. 6) with anterior arm stout, of various shapes; posterior arm with tip roundly bulbous in posterior aspect, anterior face of bulbous tip armed with small teeth; functional orifice below the apex on posterior face of posterior arm, obovate, equalling ¼ the height of the arm.

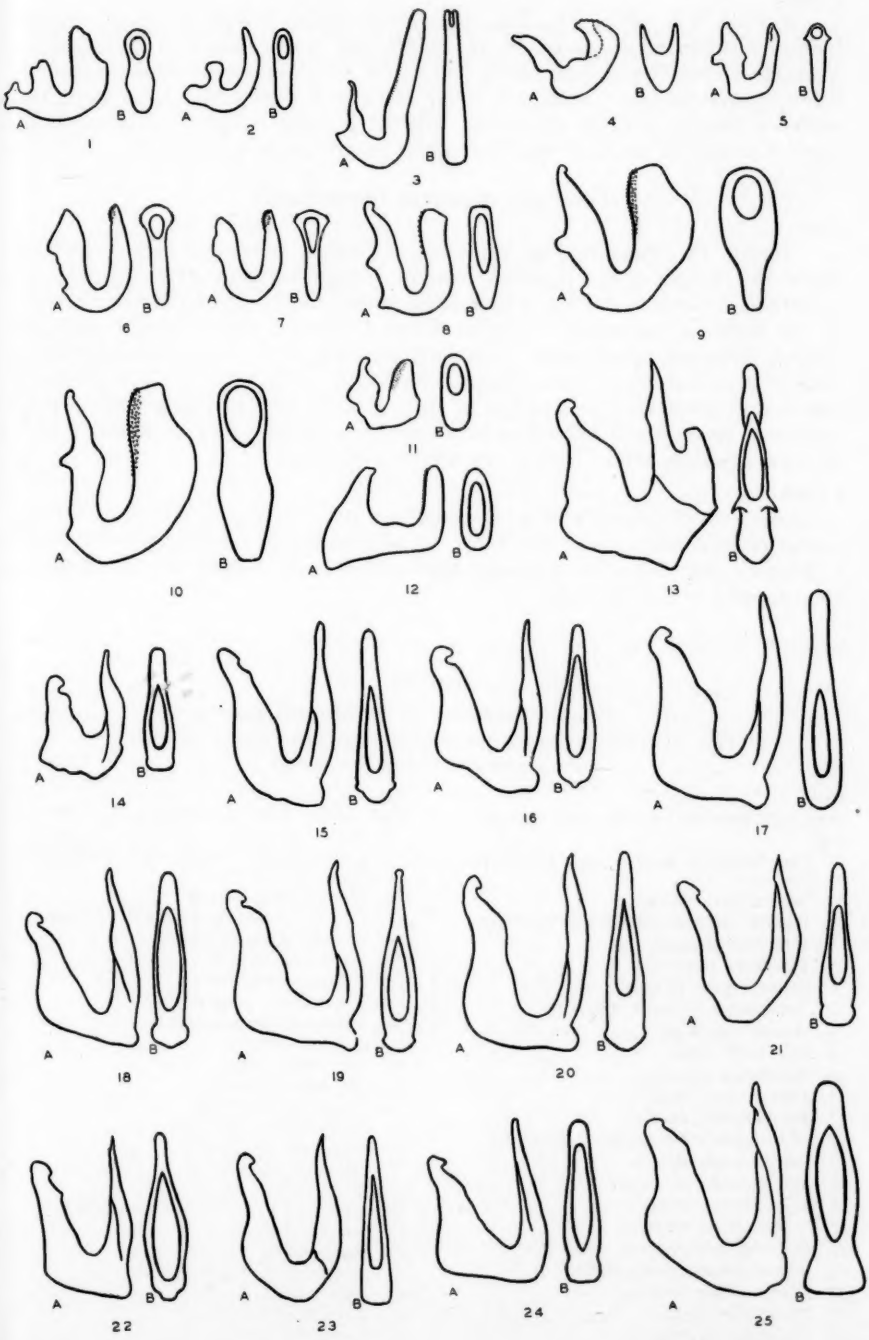
Plate III

Male Genitalia of Membracidae—aedeagi

All are drawn to the same scale except 12 which is twice the scale of the others.
A, shows a left lateral view; B, the posterior arm in posterior aspect.

FIG.
1. *Campylenchia latipes*
2. *Enchenopa binotata*
3. *Microcentrus caryae*
4. *Entylia bactriana*
5. *Pubilia concava*
6. *Vanduzea arquata*
7. *Vanduzea triguttata*
8. Smiliini, general type
9. Telamonini, general type
10. *Thelia bimaculata*
11. *Acutalis tartarea*
12. *Micrutalis calva*
13. *Spissistilus borealis*

FIG.
14. *Stictocephala lutea*
15. *Stictocephala basalis*
16. *Stictocephala albescens*
17. *Stictocephala diceros*
18. *Stictocephala brevitylus dolichotylus*
19. *Stictocephala taurina*
20. *Stictocephala bubalus*
21. *Stictocephala taurinaformis*
22. *Stictocephala constans*
23. *Stictocephala palmeri*
24. *Tortistilus inermis*
25. *Tortistilus curvata*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Female

Sternite VII (Plate IV, Fig. 4) with posterior margin a broad, round-bottomed notch which equals ⅗ the width and ¾ the depth of the segment. Valvulae 1 with tips sinuate above and below with transverse ridges extending below ventral margin. Valvula 2 (Plate IV, Fig. 27) with four large teeth, the posterior margin of tooth 4 obsolete; may be dorsally irregular or entire from tooth 4 to bluntly pointed tip. Valvulae 3 broadened in posterior ⅓.

Vanduzea triguttata (Burmeister)

Male

Tergite IX (Plate II, Fig. 18) with an oblique transverse carina reaching below the middle of the posterior margin. Subgenital plate (Plate II, Fig. 7) constricted at basal ⅕, widest at basal 3/10, longitudinally split from distal margin ½ the depth of the segment. Styles (Plate I, Fig. 9) with posterior arms recurved, divergent, apices blunt; posterior arms with a few lateral and dorsal hairs in distal ½. Connective heart-shaped. Aedeagus (Plate III, Fig. 7) in posterior aspect with posterior arm enlarged at apex, anterior face of enlargement armed with small teeth; functional orifice below apex on posterior face of posterior arm, obovate, equalling almost 7/16 of the height of the arm.

Female

Sternite VII (Plate IV, Fig. 5) narrowest at basal margin, otherwise similar to that of *V. arquata*. Valvulae 1 and 3 similar to those of *V. arquata*. Valvula 2 (Plate IV, Fig. 28) with three large teeth and dorsally coarsely serrate or entire from tooth 3 to rounded tip.

Plate IV

Female Genitalia of Membracidae

Figs. 1-8, 10-22 and 24 are drawn to the same scale; figs. 9, 23, 25-45 are drawn at 2.5 times this scale.

FIG.

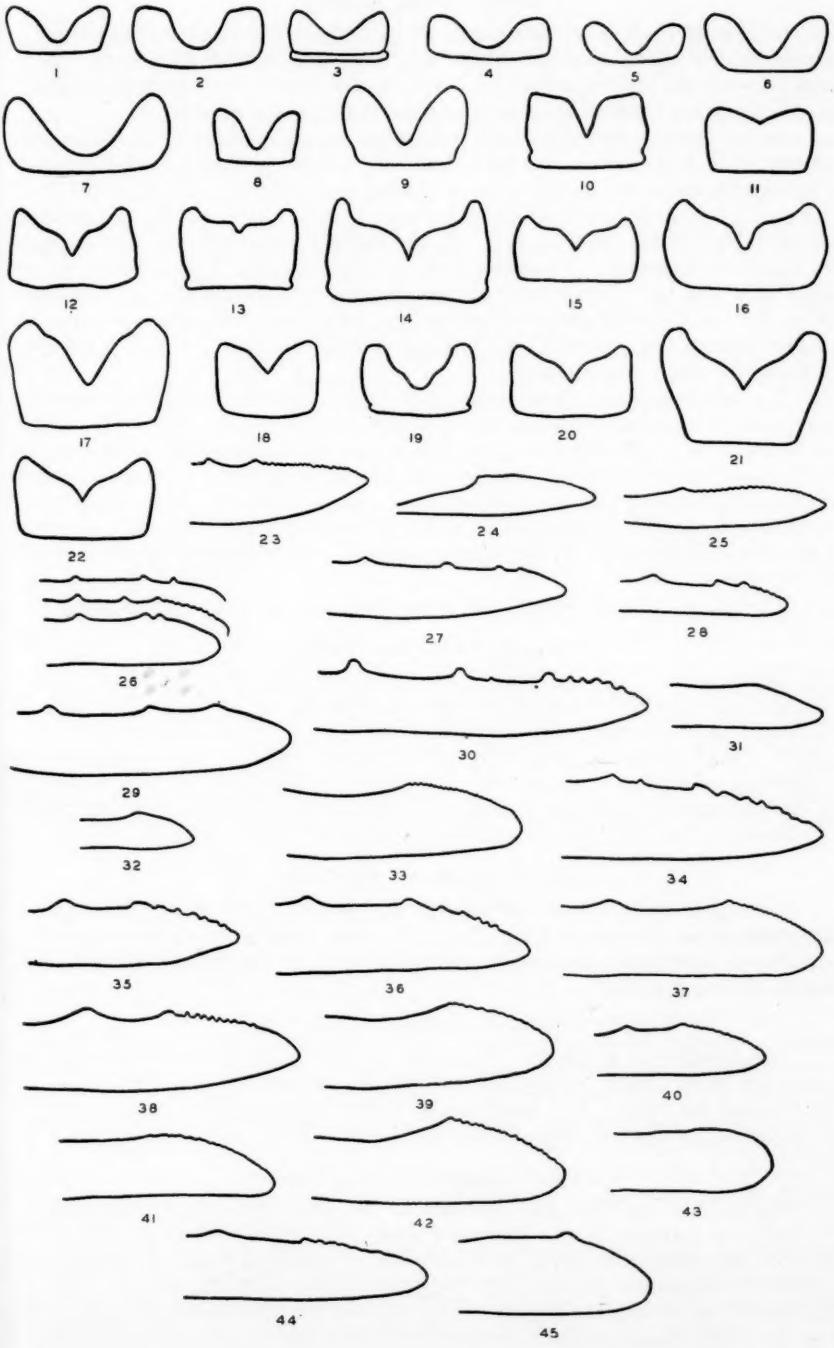
Figs. 1-22 Sternite VII. Posterior margin at top.

1. *Campylenchia latipes* and *Enchenopa binotata*
2. *Microcentrus caryae*
3. *Publilia concava* and *Entylia bactriana*
4. *Vanduzea arquata*
5. *Vanduzea triguttata*
6. Smiliini, general type
7. Telamonini, general type
8. *Acutalis tartarea*
9. *Micrutalis calva*
10. *Spissistilus borealis*
11. *Stictocephala lutea*
12. *Stictocephala basalis*
13. *Stictocephala brevitylus dolichotylus*
14. *Stictocephala diceros*
15. *Stictocephala albescens*
16. *Stictocephala bubalus*
17. *Stictocephala taurina*
18. *Stictocephala palmeri*
19. *Stictocephala taurinaformis*
20. *Stictocephala constans*
21. *Tortistilus curvata*
22. *Tortistilus inermis*

FIG.

Figs. 23-45. Tips of valvula 2. Left lateral aspect.

23. *Campylenchia latipes* and *Enchenopa binotata*
24. *Microcentrus caryae*
25. *Publilia concava* and *Entylia bactriana*
26. Smiliini, general types
27. *Vanduzea arquata*
28. *Vanduzea triguttata*
29. Telamonini, general type
30. *Telamona ampelopsidis*
31. *Acutalis tartarea*
32. *Micrutalis calva*
33. *Spissistilus borealis*
34. *Stictocephala bubalus*
35. *Stictocephala albescens*
36. *Stictocephala diceros*
37. *Stictocephala taurina*
38. *Stictocephala basalis*
39. *Stictocephala brevitylus dolichotylus*
40. *Stictocephala lutea*
41. *Stictocephala palmeri*
42. *Stictocephala taurinaformis*
43. *Stictocephala constans*
44. *Tortistilus inermis*
45. *Tortistilus curvata*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Tribe Smiliini Goding

This tribe has a generalized type of genitalia. The genital morphology is almost useless taxonomically. There is much variation within genera, species and even on the same specimen. However, the connective together with pronotal characters is used to delimit the genus *Xantholobus* Van Duzee.

In the Smiliini the males have the lateral valves without teeth. The subgenital plate is constricted at the basal 1/10, slightly widened in the basal ⅓, then slightly narrowed to the rounded tip and longitudinally split from the distal margin ¼ to ½ the depth of the segment. It may have a slight, median basal notch. The styles (Plate I, Fig. 10) are slightly recurved, the tips strongly divergent and variable. The connective is also variable. The aedeagus (Plate III, Fig. 8) has the anterior arm variable, with or without anterior and posterior lobes; the posterior arm has its anterior face with small teeth above an obsolete median groove, the posterior face bears the functional orifice which is elongate and slightly above the middle.

The female genitalia have sternite VII (Plate IV, Fig. 6) with the posterior margin a wide, round-bottomed notch which reaches slightly over ¾ the depth of the segment. Valvulae 1 have the tips sinuate above and below and blunt, and with transverse ridges which may or may not extend below the ventral margin. Valvula 2 (Plate IV, Fig. 26) seems to have a basic pattern of three teeth, but is variable and may be dorsally serrate or entire from distal tooth to tip. Valvulae 3 are narrow in the basal ½ then rather abruptly broadened dorsally and tapering to the rounded tip.

The species considered here are those listed by the author (Dennis, 1951).

Genus *Cyrtolobus* Goding

The genitalia of all the assigned species contain the described tribal characteristics but apparently cannot be used to separate the species. Genitalia of *C. tuberosus* (Fairmaire) are especially robust. The form of subgenital plate usually found in this genus is shown in Plate II, Fig. 8. The usual type of connective occurring in this genus is illustrated in Plate II, Fig. 38. Variations of the connective sometimes found in *C. tuberosus* and *C. griseus* Van Duzee are shown in Plate II, Figs. 39 and 40, respectively.

Genus *Ophiderma* Fairmaire

Here again the genitalia seem to have no specific significance. The typical subgenital plate is shown in Plate II, Fig. 9. The usual forms of the connective for the six Wisconsin species are shown in Plate II, Figs. 41 to 46, but these shapes are not constant.

Genus *Smilia* Germar

The genitalia of *S. camelus* (Fabricius) exhibit tribal characteristics but are somewhat more robust as probably should be expected in one of the larger members of the tribe. The usual forms of the subgenital plate and connective are illustrated in Plate II, Figs. 10 and 37, respectively.

Genus *Xantholobus* Van Duzee

The males of the Wisconsin members of this genus have the connective with the incurved anterior margin bearing a small median protuberance. The usual form of the connective found in *X. lateralis* (Van Duzee) and *X. intermedius* (Emmons) is shown in Plate II, Fig. 47. The connective of *X. muticus* (Fabricius) often appears slightly more elongate and is illustrated in Plate II, Fig. 48. The subgenital plate is shown in Plate II, Fig. 8.

Tribe Telamonini Goding

The species treated here have been listed by the author (Dennis, 1951). However, *Telamona compacta* Ball was not available for study. The species listed as *Telamona wescotti* Goding should, of course, be *T. westcotti* Goding.

The members of this tribe have a robust type of genitalia. But there is much variation within genera and species, and the genitalia appear to be of little use for the separation of genera and species.

The male genital structures are, in general, as follows: The lateral valves are without teeth. The subgenital plate (Plate II, Fig. 11) is as in the Smiliini, with that of *Thelia bimaculata* (Fabricius) (Plate II, Fig. 12) varying slightly from this by being narrower apically. The styles (Plate I, Fig. 11) have the anterior arms broad and lunate; the posterior arms have the tips variable, usually recurved, divergent, with a recurved apical hook which is acute anteriorly; posterior arms with dorsal surfaces in distal ½ and posterior margins with a variable pattern of short to moderately long hairs. The connective (Plate II, Fig. 49) has the anterior margin incurved, then is broadly rounded to the posterior point. Again *T. bimaculata* (Plate II, Fig. 50) varies from this. Its connective is blunter on the posterior and anterior margins. The aedeagus (Plate III, Fig. 9) is similar to that of the Smiliini but is more robust. It has the posterior arm with its anterior face bearing small teeth above and ½ to ⅔ the way down the sides of a median groove. The functional orifice is on the posterior face of the posterior arm near the apex. The aedeagus of *T. bimaculata* is shown in Plate III, Fig. 10.

The female genital parts may be characterized as follows: Sternite VII (Plate IV, Fig. 7) has the posterior margin a deep, wide, round-bottomed notch reaching slightly over ¾ the depth of the segment. The sides of the notch are usually non-sinuate, but they may be slightly sinuate in *Glossonotus univittatus* (Harris), *T. bimaculata*, and *Heliria molaris* (Butler). Valvulae 1 have the tips narrowed, sinuate above and below and with transverse ridges extending below the ventral margin. Valvula 2 (Plate IV, Fig. 29) has three large teeth and is dorsally entire from distal tooth to tip except for that of *Telamona ampelopsidis* (Harris) (Plate IV, Fig. 30) which is dorsally coarsely serrate from distal tooth to tip. Valvulae 3 are as in the Smiliini.

Tribe Ceresini Goding

It is in this tribe that the genitalia appear to be the most useful in taxonomy. The morphology of the male genitalia of the species studied places the genera *Stictocephala* Stal, *Spissistilus* Caldwell, and *Tortistilus* Caldwell in a group with teeth on the lateral valves and having the styles straight, convergent or somewhat curved dorsally. *Micrutalis* Fowler and *Acutalis* Fairmaire belong to another group having no teeth on the lateral valves and having the styles strongly recurved and divergent. Males of this tribe usually have the styles with the anterior arms slender and of variable length. All the females of the species of this tribe studied have valvulae 1 with the tips narrowed, sinuate both above and below and with transverse ridges extending below the ventral margin. Valvulae 2 are variable. All have valvulae 3 narrow in basal ½, then rather abruptly broadened dorsally and tapered to the rounded tip.

Caldwell's (1949) revision was based on the male genitalia only, but the morphology of valvula 2 of the female ovipositor can be used in the erection of three groups of the species considered here which do not correspond with Caldwell's groupings. These are comprised as follows:

Group I. Valvula 2 dorsally coarsely serrate before the tip.

1. *Stictocephala albescens* (Van Duzee)
2. *Stictocephala basalis* (Walker)
3. *Stictocephala bubalus* (Fabricius)
4. *Stictocephala diceros* (Say)
5. *Tortistilus inermis* (Fabricius)

Group II. Valvula 2 dorsally finely serrate before the tip.

1. *Spissistilus borealis* (Fairmaire)
2. *Stictocephala brevitylus dolichotylus* Caldwell
3. *Stictocephala lutea* (Walker)
4. *Stictocephala palmeri* (Van Duzee)
5. *Stictocephala taurina* (Fitch)
6. *Stictocephala taurinaformis* Caldwell

Group III. Valvula 2 dorsally entire before the tip.

1. *Acutalis tartarea* (Say)
2. *Micrutalis calva* (Say)
3. *Stictocephala constans* (Walker)
4. *Tortistilus curvata* (Caldwell)

However, the limited fauna considered to date is not believed to be an adequate basis for tribal reassignments.

Acutalis tartarea (Say)

Male

Lateral valves without teeth. Subgenital plate (Plate II, Fig. 14) long, constricted in basal ⅙, widest at basal ⅓, then narrowing to tip, longitudinally split from distal margin ⅔ its length. Styles (Plate I, Fig. 12) with anterior arms slender; swollen at connective; posterior arms recurved, divergent; apices rather acute; posterior arms with a few distal hairs. Connective (Plate II, Fig. 51) heart-shaped. Aedeagus (Plate III, Fig. 11) with anterior arm variable, usually with a pair of anterior lobes and a posterior lobe; posterior arm with anterior face bordered with small teeth, posterior face with functional orifice situated in upper ½, oval, equalling slightly less than ½ the height of the arm.

Female

Sternite VII (Plate IV, Fig. 8) with almost parallel sides, posterior margin a deep, round-bottomed V-shaped notch reaching 5/7 the depth of the segment. Valvula 2 (Plate IV, Fig. 31) slightly broadened and dorsally entire before the tip.

A. semicrema (Say) is considered synonymous with the typical *tartarea* because specimens in the author's collection show color gradations between them, and there are no constant differences in genital morphology.

Micrutalis calva (Say)

Male

Lateral valves without teeth. Subgenital plate (Plate II, Fig. 13) constricted in basal 1/7, widest at basal ¼, narrowing in distal ⅜, slightly wider at tip, longitudinally split from distal margin slightly less than ½ its length. Styles (Plate I, Fig. 13) with anterior arms slender; strongly swollen at connective; posterior arms dorsally curved, divergent, tips with a flattened recurved hook; styles without hairs. Connective (Plate II, Fig. 52) with anterior margin notched; sides slightly divergent posteriorly; posterior margin truncate. Aedeagus (Plate III, Fig. 12) with anterior arm stout basally; distance between anterior and posterior arms 2½ times width of posterior arm; posterior arm with teeth on

anterior face clustered at tip and down the edges; functional orifice in centre on posterior face, oval, equalling ⅜ the height of the arm.

Female

Sternite VII (Plate IV, Fig. 9) narrowest at basal margin; posterior margin a deep, round-bottomed V-shaped notch reaching ⅔ the depth of the segment. Valvula 2 (Plate IV, Fig. 32) broadened and dorsally entire before the tip.

Genus *Stictocephala* Stal

The males of *Stictocephala* have the lateral valves with teeth which are usually as long as or longer than the width of the valve. The subgenital plate (Plate II, Fig. 15) is broadly rounded basally, narrowed in the distal half; distal margin with a small, acute notch. The styles have the anterior arms variable but the posterior arms constant within the species as far as is known. The aedeagus has the anterior arm variable, and the elongate functional orifice is on the posterior face of the posterior arm.

Stictocephala albescens (Van Duzee)

Male

Teeth of lateral valves (Plate II, Fig. 24) slender, gradually narrowed apically. Styles (Plate I, Fig. 15) with posterior arms upturned, slightly convergent; tips serrate in ventrolateral aspect; posterior arms with outer and inner margins each with a row of moderately long hairs in distal ½ to ⅔. Connective (Plate II, Fig. 54) elliptical except for a shallow notch on anterior margin. Aedeagus (Plate III, Fig. 16) distinctly lobed at connective; top of lateral membranes below middle; functional orifice in the middle of the arm, elongate-oval, equalling ⅔ the height of the arm.

Female

Sternite VII (Plate IV, Fig. 15) with posterior margin an acute-bottomed notch with sinuate sides, reaching ½ the depth of the segment. Valvula 2 (Plate IV, Fig. 35) with one large tooth somewhat removed from the coarse dorsal serrations before the tip, or sometimes apparently with two large teeth and dorsally coarsely serrate before the tip.

Stictocephala basalis (Walker)

Male

Teeth of lateral valves (Plate II, Fig. 21) narrowed apically. Styles (Plate I, Fig. 23) with posterior arms upturned; tips acute; posterior arms with outer margins with short hairs in distal ¾, inner margins with short hairs in distal ½. Connective as in *S. albescens*. Aedeagus (Plate III, Fig. 15) distinctly lobed at connective; top of lateral membranes below the middle; functional orifice closer to bottom than top, rounded below, tapering to acute top, equalling ½ the height of the arm.

Female

Sternite VII (Plate IV, Fig. 15) with posterior margin an acute-bottomed notch with sinuate sides reaching ⅔ the depth of the segment. Valvula 2 (Plate IV, Fig. 38) with two large teeth and dorsally coarsely serrate before the tip, or sometimes with a single large tooth somewhat removed from the coarse dorsal serrations before the tip.

Stictocephala brevitylus dolichotylus Caldwell

This species was listed by the author (Dennis, 1951) as *S. brevitylus* Van Duzee, but further study indicates that *dolichotylus* is the form considered.

Male

Teeth of lateral valves (Plate II, Fig. 22) blunt, almost parallel-sided. Styles (Plate I, Fig. 24) with posterior arms upturned, almost straight in dorsal aspect; tips serrate on inner margins; posterior arms with inner and outer margins each with a row of long hairs in distal ½ becoming dorsal distally. Connective as in *S. albescens*. Aedeagus (Plate III, Fig. 18) distinctly lobed at the connective; top of lateral membranes below the middle; functional orifice in the middle, elongate, rounded below, widest at middle, top obtuse, equalling ⅔ the height of the arm.

Female

Sternite VII (Plate IV, Fig. 13) with posterior margin a shallow notch with strongly sinuate sides reaching ¼ the depth of the segment. Valvula 2 (Plate IV, Fig. 39) narrowed before the fine dorsal serrations before the tip.

***Stictocephala bubalus* (Fabricius)**

Male

Teeth of lateral valves (Plate II, Fig. 28) broad and blunt. Styles (Plate I, Fig. 18) with posterior arms upturned, almost straight in dorsal aspect; tips acuminate; posterior arms with outer margins with a row of short hairs in distal ½, inner margins with a similar row usually in distal ⅓ but may approach ½. Connective as in *S. albescens*. Aedeagus (Plate III, Fig. 20) distinctly lobed at connective; top of lateral membranes below the middle; functional orifice at about the middle, rounded below, acute above, equalling ½ the height of the arm.

Female

Sternite VII (Plate IV, Fig. 16) with posterior margin a subacute-bottomed notch with broadly sinuate sides reaching ½ the depth of the segment. Valvula 2 (Plate IV, Fig. 34) with two large teeth and dorsally coarsely serrate before tip, or sometimes with apparently a single large tooth somewhat removed from the coarse dorsal serrations before the tip.

***Stictocephala constans* (Walker)**

Male

Teeth of lateral valves acute (Plate II, Fig. 26). Styles (Plate I, Fig. 22) with posterior arms upturned, slightly convergent at tips; tips acuminate; posterior arms with inner and outer margins in distal ½ and tips dorsally with moderately long hairs. Connective as in *S. albescens*, sides diverging to being widest at middle. Aedeagus (Plate III, Fig. 22) lobed at connective, top of lateral membranes at the middle; functional orifice large, rounded at bottom, widest at middle and acute at top, equalling ⅔ the height of the arm.

Female

Sternite VII (Plate IV, Fig. 20) variable but generally with posterior margin a notch with broadly sinuate sides reaching about ½ the depth of the segment. Valvula 2 (Plate IV, Fig. 43) dorsally entire before the very bluntly rounded tip.

***Stictocephala diceros* (Say)**

Male

Teeth of lateral valves (Plate II, Fig. 23) somewhat narrowed apically. Styles (Plate I, Fig. 16) with posterior arms slightly upturned, almost straight in dorsal aspect; tips acuminate; posterior arms with outer margins with a row of moderately long hairs in distal 9/10, becoming dorsal basally, inner margins with a row of moderately long hairs in distal ½ to ⅔. Connective as in *S. albescens*. Aedeagus (Plate III, Fig. 17) distinctly lobed at the connective; top of lateral membranes below the middle; functional orifice below the middle, rounded below, tapering to an acute top, equalling 5/13 the height of the arm.

Female

Sternite VII (Plate IV, Fig. 14) with posterior margin an acute-bottomed notch with strongly sinuate sides reaching ⅝ the depth of the segment. Valvula 2 (Plate IV, Fig. 36) with two large teeth and dorsally coarsely serrate before the tip, or sometimes with apparently only one large tooth somewhat removed from the coarse dorsal serrations before the tip.

***Stictocephala lutea* (Walker)**

Male

Teeth of lateral valves slender (Plate II, Fig. 29). Styles (Plate I, Fig. 17) with posterior arms upturned; tips acuminate, slightly convergent; posterior arms with a fringe of short hairs on outer margins in distal ½ and a short dorsal row of short hairs at the tip. Connective (Plate II, Fig. 55) elongate, slightly, broadly constricted at the middle, posterior margin slightly more rounded than anterior margin. Aedeagus (Plate III, Fig. 14) with top of lateral membranes below the middle; posterior arm with apex flattened; functional orifice near bottom of arm, rounded below and acute above, equalling ½ the height of the arm.

Female

Sternite VII (Plate IV, Fig. 11) with posterior margin a very wide, shallow, straight-sided notch. Valvula 2 (Plate IV, Fig. 40) with a single large tooth somewhat removed from the fine dorsal serrations before the tip.

***Stictocephala palmeri* (Van Duzee)**

Male

Teeth of lateral valves (Plate II, Fig. 25) bluntly pointed. Styles (Plate I, Fig. 20) with posterior arms slightly divergent at tips; tips acuminate; posterior arms with inner and outer margins in distal ½ and tips dorsally with moderately long hairs. Connective (Plate II, Fig. 57) diamond-shaped with anterior margin notched, posterior margin bluntly pointed. Aedeagus (Plate III, Fig. 23) with arms slender; lateral membranes as a basal ring; functional orifice rounded at bottom, tapering regularly to the acute top, equalling 9/16 the height of the arm.

Female

Sternite VII (Plate IV, Fig. 18) with posterior margin a wide, acute-bottomed notch with non-sinuate sides reaching almost ½ the depth of the segment. Valvula 2 (Plate IV, Fig. 41) dorsally finely serrate before the tip.

***Stictocephala taurina* (Fitch)**

Male

Teeth of lateral valves (Plate II, Fig. 27) broad, often pointed or upturned at the apex. Styles (Plate I, Fig. 19) with posterior arms upturned, slightly convergent, serrate on inner tips; posterior arms with inner and outer margins bearing long hairs in distal ½, the hairs becoming somewhat dorsal toward the apex. Connective (Plate II, Fig. 56) elongate; the anterior margin notched; rather abruptly widened at the middle and tapering to the rounded posterior tip. Aedeagus (Plate III, Fig. 19) distinctly lobed at the connective, top of lateral membranes below the middle; posterior arm slightly knobbed at tip; functional orifice toward the bottom, rounded below, acute above, equalling ½ the height of the arm.

Female

Sternite VII (Plate IV, Fig. 17) with posterior margin a wide, sub-acute-bottomed notch with sides slightly sinuate posteriorly, reaching ⅝ the depth of the segment. Valvula 2 (Plate IV, Fig. 37) with a large tooth somewhat removed from the fine dorsal serrations before the tip.

Stictocephala taurinaformis Caldwell

Male

Teeth of lateral valves (Plate II, Fig. 30) suddenly convergent and narrowed in apical ¼. Styles (Plate I, Fig. 21) with posterior arms upturned, almost straight in dorsal aspect; tips acute; posterior arms with outer and inner margins with a row of short hairs in distal ½. Connective (Plate II, Fig. 58) elongate; anterior margin with an acute notch; posterior margin with a small truncate tip. Aedeagus (Plate III, Fig. 21) with lateral membranes forming a hood-like subapical process; functional orifice in the middle, rounded at top and bottom, equalling ½ the height of the arm.

Female

Sternite VII (Plate IV, Fig. 19) with a wide, round-bottomed notch with sinuate sides equalling ⅗ the width and reaching 4/7 the depth of the segment. Valvula 2 (Plate IV, Fig. 42) curved dorsally, strongly narrowed before the fine dorsal serrations before the tip.

Genus *Spissistilus* Caldwell

One species found in Wisconsin can be assigned to this genus. Caldwell (1949) included *constans* (Walker) in this genus and *borealis* (Fairmaire) in the genus *Stictocephala.* But in the author's collection *borealis* (Fairmaire) (determined by W. D. Funkhouser) has an aedeagus as Caldwell has figured for "*constans* (Walker)" on plate 22; and the author's *constans* (Walker) has the style and teeth of the lateral valve as he has figured for "*borealis* (Fairmaire)" on plate 21. Consequently, in this paper *borealis* (Fairmaire) is assigned to *Spissistilus* and *constans* (Walker) is placed in *Stictocephala.*

Spissistilus borealis (Fairmaire)

Male

Teeth of lateral valves (Plate II, Fig. 20) strongly narrowed in apical ½. Subgenital plate as in *Stictocephala.* Styles (Plate I, Fig. 14) with posterior arms compressed; apices obtuse; posterior arms with rather long dorsal and ventral hairs in apical ⅓. Connective (Plate II, Fig. 53) with anterior margin strongly incurved; posterior margin truncate. Aedeagus (Plate III, Fig. 13) in lateral aspect with tip of posterior arm bilobed: the anterior lobe acuminate apically; the posterior lobe shorter and blunt; aedeagus in posterior aspect with two sharp lateral teeth at level of bottom of orifice; posterior lobe with functional orifice on posterior face; orifice rounded at bottom, acute at top, equalling ½ the height of the posterior lobe.

Female

Sternite VII (Plate IV, Fig. 10) constricted near base; posterior margin almost straight with an acute median notch reaching 4/7 of the depth of the segment. Valvula 2 (Plate IV, Fig. 33) with fine dorsal serrations before the tip.

Genus *Tortistilus* Caldwell

Tortistilus curvata (Caldwell)

This species is assigned to *Tortistilus* on the basis of the type of style. The only character used by Caldwell (1949) in the erection of the genus which does not fit this species is the very short teeth of the lateral valves which he characterized as being "shorter than the width of the valves." However, it is pointed out here that though the teeth are rarely as short as those of *T. inermis* (Say), many specimens of various other Wisconsin species have the teeth shorter than the width of the valves.

Male

Teeth of lateral valves (Plate II, Fig. 32) almost as long as the valves are wide. Subgenital plate as in *Stictocephala*. Styles (Plate I, Fig. 26) with posterior arms depressed, S-shaped in dorsal aspect; tips with apices and inner margins serrate; posterior arms with inner and outer margins in distal ⅔ and dorsally near tip with long hairs. Connective (Plate II, Fig. 60) elongate heart-shaped. Aedeagus (Plate III, Fig. 25) with anterior arm stout basally; posterior arm with anterior face bearing a small, hood-like sub-apical process and with the lateral membranes below this, posterior face with the functional orifice; orifice elongate, in the middle of the arm, rounded below, widest at its middle and subacute above, equalling slightly over ½ of the height of the arm.

Female

Sternite VII (Plate IV, Fig. 21) narrowest at basal margin; sides divergent; posterior margin with an acute-bottomed, sinuate-sided notch reaching ½ the depth of the segment. Valvula 2 (Plate IV, Fig. 45) upturned, with a single large tooth and dorsally entire from tooth to tip.

***Tortistilus inermis* (Say)**

Male

Lateral valves each with a tooth (Plate II, Fig. 31) which is shorter than the width of the valve. Subgenital plate as in *Stictocephala*. Styles (Plate I, Fig. 25) with posterior arms depressed, S-shaped in dorsal aspect; tips with apices and inner margins serrate; posterior arms with inner and outer margins in distal ½ and dorsally near the tip with long hairs. Connective (Plate II, Fig. 59) elongate heart-shaped, slightly narrowed posteriorly. Aedeagus (Plate III, Fig. 24) with anterior arm stout basally; posterior arm in lateral aspect slender; top of lateral membranes above the middle; posterior arm with posterior face bearing the functional orifice; orifice elongate, in the middle of the arm, subacute at bottom, rounded at top, equalling ⅔ the height of the arm.

Female

Sternite VII (Plate IV, Fig. 22) with posterior margin an acute-bottomed notch with sinuate sides reaching ½ the depth of the segment. Valvula 2 (Plate IV, Fig. 44) straight and with a single large tooth somewhat removed from the coarse dorsal serrations before the tip.

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Effects of Certain Climatic Factors on the Daily Abundance of the European Earwig, *Forficula auricularia* L. (Dermaptera: Forficulidae), in Vancouver, British Columbia[1]

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Introduction

During September, 1950, 23,180 specimens of the European earwig, *Forficula auricularia* L., were collected in Vancouver, British Columbia, for the purpose of recovering the imported parasite *Bigonicheta setipennis* (Fall.). Great fluctuations were observed in the number of insects caught from day to day. This paper is an attempt to assess the role of various climatic factors in these fluctuations.

Descriptions of the life-history and habits of the European earwig were given by Glendenning (1947) and Gibson and Glendenning (1925).

The earwig, being a nocturnal insect, spends the entire period of daylight hiding under trash or in dark crevices. Because of the strong negative phototaxis exhibited by these insects, it was decided to collect them by using a type of trap that would provide them with dark shelter during daylight. It might be assumed that the number of earwigs collected each day from the traps reflected the activity of the population during the previous night. However, for the purposes of this paper, the word *abundance* will be used because there is no conclusive evidence that there is a direct relationship between activity and abundance.

Weather records for September were obtained from the Vancouver office, Meteorological Division, Canada Department of Transport. These records were made at Sea Island Airport, which is approximately 5¼ miles from the collection areas and about 250 feet lower in altitude. Possibly the numerical values for the various climatic factors varied between the collection areas and the point of climatic observation, but it must be assumed that the relative fluctuations of each factor remained the same. This assumption is borne out by the close agreement found between the fluctuations in the earwig abundance and those of many of the factors considered. The probability of these fluctuations agreeing so closely merely because of chance is slight, as shall be shown.

If the purpose of this paper had been to show a correlation in the degree of fluctuation evident between the climatic values and earwig abundance, it would have been necessary to apply a correction to each of the climatic factors considered. However, the purpose of this paper is merely to show the relationships between the daily fluctuations in the various climatic factors and in earwig abundance.

Acknowledgments

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Methods

The traps used in collecting the earwigs were made from cedar boards 18

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inches long, eight inches wide, and half an inch thick. These boards were cut with grooves one-quarter of an inch by one-quarter of an inch in every half inch of width so that, when two boards were fastened together with the grooved surfaces facing each other, dark tunnels were formed which proved to be ideal hiding places for the insects. The boards were fastened together with either rubber bands or wire clips.

The traps were placed in trees about five feet from the ground, and were emptied every morning during September.

Two collection areas one-quarter of a mile apart were used, one having 25 traps and the other 15. On only one occasion did the investigators alter the position of any trap: on September 7, three traps were moved to more suitable locations within the trapping area. Some degree of error may have been introduced because of the fact that on nights of high wind velocity the traps were prone to fall from their positions in the trees. The maximum number altered in this way was six, on September 4; however, these would be errors of omission rather than of addition, and would merely serve to depress the peaks in earwig abundance, which will be shown to have occurred on nights of high wind velocity, and to raise the low levels in abundance, which occurred on nights of low wind velocity.

The figures for daily earwig abundance used throughout this paper represent the sum of the numbers of earwigs caught in the two areas each day.

The weather records gave the following information: hourly readings for temperature, wind velocity and direction, and atmospheric pressure; and readings for relative humidity and cloud cover at 4.30 and 10.30 a.m., and at 4.30 and 10.30 p.m.

In all cases where climatic values recorded before midnight (e.g., wind velocity from 8.00 to 12.00 p.m.) were compared with any day's earwig abundance, the figures for the evening before the day of collection were used. Therefore, in Fig. 1, D, the average wind velocity shown for any date occurred in reality the previous evening. This was necessary because, as stated above, the collections were made each morning. Naturally, the wind velocity in the evening could not affect the collection made before that time, but could affect the following morning's collection.

An analysis of co-variance technique (Snedecor, 1946) was used to analyse the data. The factors amenable to this method of analysis were: temperature, temperature range, wind velocity, relative humidity, and atmospheric pressure.

The coefficient of correlation (r) between each factor and earwig abundance was calculated by the formula:

$$r_{yx}=\frac{\Sigma(y-\bar{y})\ (x-\bar{x})}{\sqrt{[\Sigma(y-\bar{y})^2]\ \Sigma(x-\bar{x})^2]}},$$

where y=earwig values; x=factor values; $\bar{y}$ and $\bar{x}$=mean values; and r=correlation coefficient.

The t value of the correlation coefficient (r) of each factor was obtained by means of the formula:

$$t=\frac{r_{yx}}{\sqrt{1-r^2_{yx}}}\ \mathrm{X}\ \sqrt{n-2}.$$

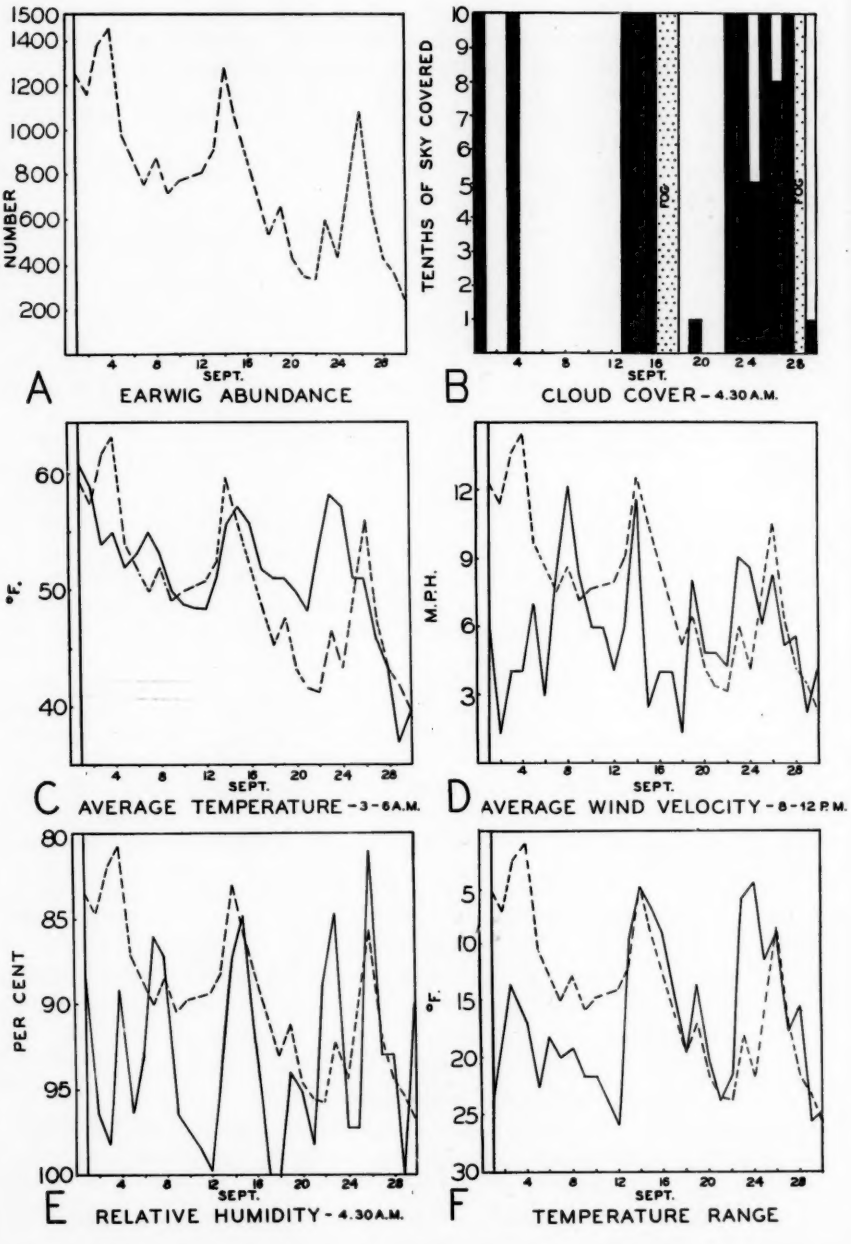

FIG. 1. Daily fluctuations in European earwig abundance and in various individual climatic factors at Vancouver during September, 1950. In E the scale for relative humidity has been inverted. Legend: Earwig abundance: (—); Climatic factors: (—).

The calculated t value was then compared with the value shown in a table of t (Snedecor, 1946) at $n-2$ degrees of freedom.

The next step was to apply the values of the significant factors as a group to the earwig abundance values as follows:

$$q = (y - b_1x_1 - b_2x_2 - b_3x_3 - c)^2,$$

where x_1 represents temperature, x_2 represents temperature range, and x_3 represents wind velocity. The symbol q is a measure of the amount of difference between the observed and the calculated earwig abundance.

It was necessary to find the values of b_1, b_2, and b_3, and of c, making q as small as possible. All the values for earwig abundance and for the climatic factors were taken with their origins at a mean, i.e., $y—\bar{y}$, $x—\bar{x}$, *so that* $c=0$.

To calculate the values of b_1, b_2, and b_3, the following formulae were used:

$$(Y-\bar{Y})(X_1-\bar{X}_1) = b_1\Sigma(X_1-\bar{X}_1)^2 + b_2\Sigma(X_1-\bar{X}_1)(X_2-\bar{X}_2) + b_3\Sigma(X_1-\bar{X}_1)(X_3-\bar{X}_3)$$
$$(Y-\bar{Y})(X_2-\bar{X}_2) = b_1\Sigma(X_1-\bar{X}_1)(X_2-\bar{X}_2) + b_2\Sigma(X_2-\bar{X}_2)^2 + b_3\Sigma(X_2-\bar{X}_2)(X_3-\bar{X}_3)$$
$$(Y-\bar{Y})(X_3-\bar{X}_3) = b_1\Sigma(X_1-\bar{X}_1)(X_3-\bar{X}_3) + b_2\Sigma(X_2-\bar{X}_2)(X_3-\bar{X}_3) + b_3\Sigma(X_3-\bar{X}_3)^2.$$

The various components of the above equations were calculated and substituted for their symbolic designations. The values of b_1, b_2, and b_3 were then calculated by the Doolittle method of solving normal equations (Mills, 1938). The values were:

$$b_1 = +31.7942$$
$$b_2 = -\ 1.2272$$
$$b_3 = -\ 5.0828.$$

The multiple correlation coefficient (R) of y on x_1, x_2, and x_3 was then calculated by means of the formula:

$$R^2 = b_1\frac{(y—\bar{y})\,(x_1—\bar{x}_1)}{(y—\bar{y})^2} + b_2\frac{(y—\bar{y})\,(x_2—\bar{x}_2)}{(y—\bar{y})^2} + b_3\frac{(y—\bar{y})\,(x_3—\bar{x}_3)}{(y—\bar{y})^2}$$

R^2 was found to equal +.281159. The F value of the multiple correlation coefficient squared was then calculated by means of the formula:

$$F = \frac{R^2}{1—R^2} X \frac{n—k—1}{k},$$

where k = the number of variables.

Results and Discussion

Fig. 1, A, shows the total numbers of earwigs caught during September. Evidently there were three periods of peak abundance and three of moderate abundance. The writers propose to show that these fluctuations were caused by certain climatic factors.

During the month the trend in earwig abundance definitely diminished, a fact that has two possible explanations. The first is that the concentrated trapping over a limited area reduced the population. This is improbable because earwigs are vagrant insects that seem to wander very extensively and hence the populations of the trapped areas would be replenished constantly by earwigs

wandering in from neighbouring areas. The second and more plausible explanation is that as the autumn advanced and the weather became more inclement a progressively increasing number of earwigs hibernated.

Temperature

The first climatic factor considered was temperature. As the earwig is nocturnal, only the temperatures for the period from a few hours before sunset to a few hours after dawn were considered likely to affect its activity. This would hold true for all the factors considered except temperature range. It was reasoned that there were two occasions when the influence of any factor would be greatest: the time of commencement of activity and the time of cessation. However, the other periods during the night were not neglected.

Graphs for the average nightly temperature for the three-hour periods from 6.00 p.m. to 6.00 a.m. showed that all the average temperatures had some degree of agreement with earwig abundance, but that those for the period 3.00 to 6.00 a.m. apparently exerted the greatest influence on the insect population. The graph for this period is shown as Fig. 1, C. For every peak in the line of earwig abundance (Fig. 1, A), there was a peak in the graph for the average temperatures. In two instances the peak in temperature did not occur on the same day as the peak in earwig abundance. In one case the peak occurred one day before the high level of earwig abundance. There were no correspondingly high average temperatures for the peaks in abundance occurring on September 19 and 26.

The daily minimum and maximum temperatures and the average daily temperature were also plotted. The minimum daily temperature had a direct relationship to earwig abundance, whereas the daily maximum temperature had an inverse relationship. The average daily temperature was found to have little correlation. Because of these phenomena, the daily ranges in temperature were plotted for the month as Fig. 1, F. This factor was found to have a close inverse relationship to earwig abundance. In other words, the more stable the daily temperature, the more abundant were the earwigs in the traps. This is in agreement with Davidson and Andrewartha (1948), who found the temperature range to have a definite influence on the abundance of a thrips population.

Relative Humidity

Daily readings were available for 10.30 p.m. and 4.30 a.m. only. The relative humidity at 4.30 a.m. (Fig. 1, E) had an inverse relationship to earwig abundance. Uvarov (1931) found that in Lepidoptera, above 54 per cent R.H., there was an inverse relationship between relative humidity and activity; below 54 per cent the relationship was direct. It is unfortunate that 81 per cent was the lowest humidity recorded during the month of this study, so that the effect of low humidity could not be tested in connection with the earwig.

Fig. 1, E, shows a close, inverse relationship between relative humidity at 4.30 a.m. and earwig abundance (the relationship appears to be direct because the scale was inverted).

Atmospheric Pressure

The results obtained from consideration of atmospheric pressure data showed that this factor played no important part in influencing earwig abundance. Both the average nightly atmospheric pressure, and the atmospheric pressure range for the 24-hour period from dawn to dawn, had little agreement with earwig abundance. Averages for each three-hour period during the night had little correlation.

The failure to find any significant relationship between atmospheric pressure and earwig abundance is almost certainly not due to the distance between the

points of observation and earwig collection. Wellington (1946) states that atmospheric pressure is the climatic factor varying least with horizontal distance from the point of observation.

Wind

Wind velocity and direction were highly important factors in earwig abundance. The average wind velocity from 8.00 to 12.00 p.m. (Fig. 1, D) had the closest direct relationship to earwig abundance. When the wind velocity was high in relation to the average monthly velocity, the earwig abundance was almost always high also, and conversely. There were several periods of non-conformity, the most serious of these being on September 12 and 15. It must be that at that time other factors having a greater influence on abundance forced the abundance in a direction opposite to that of the wind velocity trend.

The reason for the relationship between wind velocity and earwig abundance has not been discovered. It was noted that earwigs in captivity are very sensitive to currents of air and, when stimulated by them, will drop from the sides of their cages.

It was observed that for the 12 to 18 hours preceding a day of great earwig abundance the wind direction was invariably easterly; on days of low abundance the wind direction was westerly, with one exception; and on days of average abundance the wind was either variable or only slightly favourable to an increase or decrease in earwig abundance. The apparent effect of wind direction is probably due to the fact that a westerly wind is produced by or produces factors unfavourable to earwig abundance, and an easterly wind produces or is produced by factors favourable to earwig abundance.

Evidently the factors that might produce or be produced by wind of a certain direction and that affect the earwig abundance have not been any of those considered up to this point. This is indicated by the fact that wind direction was unfavourable to earwig abundance on September 8, yet a peak in abundance occurred. Any factors connected with unfavourable wind direction must of necessity be unfavourable themselves, but all the factors so far considered were found to be favourable on this date.

Cloud Cover

Readings were available for 10.30 p.m. and 4.30 a.m. only; cloud cover at the latter time had a definite relationship to earwig abundance. At no time during the month did a period of great abundance occur without a corresponding period of complete cloud cover, nor did a period of complete cloud cover occur without a corresponding peak in abundance. It was also observed that periods of low earwig abundance were accompanied by periods of little or no cloud cover.

The above relationship may be seen by comparing the histogram of nightly cloud cover (Fig. 1, B) with the graph of earwig abundance (Fig. 1, A). The minor peak in earwig abundance on September 8 was not accompanied by cloud cover. It is interesting to note that this peak was accompanied by a wind of unfavourable (i.e., northwesterly) direction.

In Vancouver an easterly wind is usually accompanied by cloudy weather and a westerly wind by clear weather. This may explain the apparent effect of wind direction on earwig abundance.

The apparent influence of cloud cover is due, perhaps, to the fact that earwigs are strongly negatively phototactic and may be more active when cloud cover decreases the light intensity. On the other hand, the influence may be

due to other factors favourable to earwig abundance which become manifest during periods of cloudiness.

Statistical Analysis Results

Highly significant correlations were obtained for temperature and temperature range and a significant correlation for wind velocity. Correlations for relative humidity and atmospheric pressure were not significant, but the *t* value of the correlation coefficient for relative humidity was only slightly larger than the accepted limit of significance. The three factors having significant correlation with earwig abundance were treated as a group by means of the analysis of co-variance technique. The correlation between this group of climatic factors, i.e., temperature, temperature range, and wind velocity, and earwig abundance was significant at the three per cent level.

Summary

The effects of temperature, temperature range, wind velocity, relative humidity, atmospheric pressure, atmospheric pressure range, wind direction, and cloud cover on the daily abundance of the European earwig were studied at Vancouver, British Columbia.

The effects of wind direction and cloud cover were not analysed statistically, but they appeared to have some correlation with earwig abundance. In Vancouver, easterly winds are usually accompanied by cloudy weather and westerly winds by clear weather. The earwigs were most abundant during periods of prevailing easterly winds, and least abundant during periods of prevailing westerly winds.

When the first six factors listed above were graphed individually, it was obvious that atmospheric pressure range had no significant correlation with earwig abundance. The significance of the correlations between the remaining factors and earwig abundance was determined by calculating their individual correlation coefficients. The correlations for atmospheric pressure and relative humidity were not significant. Those for temperature and temperature range were highly significant, that for wind velocity was significant.

The three factors having significant correlation with earwig abundance were treated as a group by means of the analysis of co-variance technique. The correlation between this group of climtaic factors and earwig abundance was significant at the three per cent level.

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The Proventriculus of the Diamond Beetle, *Entimus nobilis* Oliv. (Coleoptera: Curculionidae)

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The diamond beetle, *Entimus nobilis* Oliv., is a weevil whose larva causes irregular tubercles on the woody tissues of the twining vine *Stigmaphyllum littorale* Juss., cultivated in the American tropics. Bruch (1932) reports that the adult weevil may be from 10 to 28 mm. in length. The specimens in which the proventriculus was examined were adults 28 mm. long from a series of pinned insects collected in Brazil.

A pinned beetle was placed in a strong solution of potassium hydroxide for about twenty-four hours, after which time the pin was carefully withdrawn and the integument of the mid-dorsal line of the abdomen was cut with fine scissors. The foregut, now freed from its surrounding tissues by the action of the hydroxide, was lifted from the body cavity. Strands of muscle remaining attached to it were removed with needles or by further treatment with hydroxide and it was then slit along its length with scissors. The hydroxide was removed from the tissue by several washings with water and, after dehydration by alcohols and clearing with toluol, the lining of the proventriculus was flattened out and mounted on a slide in Canada balsam.

Description of the proventriculi of weevils have been made by several authors: Lindemann (1876), Nusslin—*Hylobius abietis* (1911), Muller—*Calandra granaria* (1928), Ting (1933), Murray and Tiegs—*Calandra oryzae* (1935), Tissot—*Naupactus leucolena* (1938) and Dennell—*Calandra granaria* (1942). Dennell, in his description of the proventriculus of *Calandra granaria*, compared his findings with the descriptions made by the other authors and discussed the terms applied by them to the various structures of the proventricular armature. In the following account descriptive terms used by Dennell are used where applicable.

Description

In *Entimus nobilis* the crop and proventriculus from a sac about 1 cm. long (Fig. 1—C, P) leading posteriorly from the narrow oesophagus (O). At its posterior end the crop shows irregular transverse furrows where it joins the broad anterior opening of the proventriculus. The proventriculus narrows abruptly at its posterior end toward the oesophageal valve (OV), a short, narrow tube that projects into the midgut in the intact digestive tract. Extending from the anterior to the posterior limits of the proventriculus are eight sharply defined folds (F) each showing transverse striations owing to the presence of closely set sieve plates inside the proventriculus. In the intact digestive tract these folds form attachments for the strong circular muscles that traverse the circumference of the proventriculus.

Internally, the whole surface of the proventriculus is occupied by sixteen rows of sieve plates each row being about 4 mm. long (Fig. 2—RP). These rows of plates are grouped in pairs, the eight pairs being separated from one another by longitudinal furrows (LF) which correspond to the folds (Fig. 1—F) on the outside of the organ. Between the two rows of plates in a pair is a median furrow (MF). This median furrow is traversed along its length by two irregular rows of short median bristles (MB). At the anterior end of each row of plates is a rounded cushion covered by bristles (CB). The sieve plates (SP) are thin, sclerotized extensions of the intima of the proventriculus. There are about 150

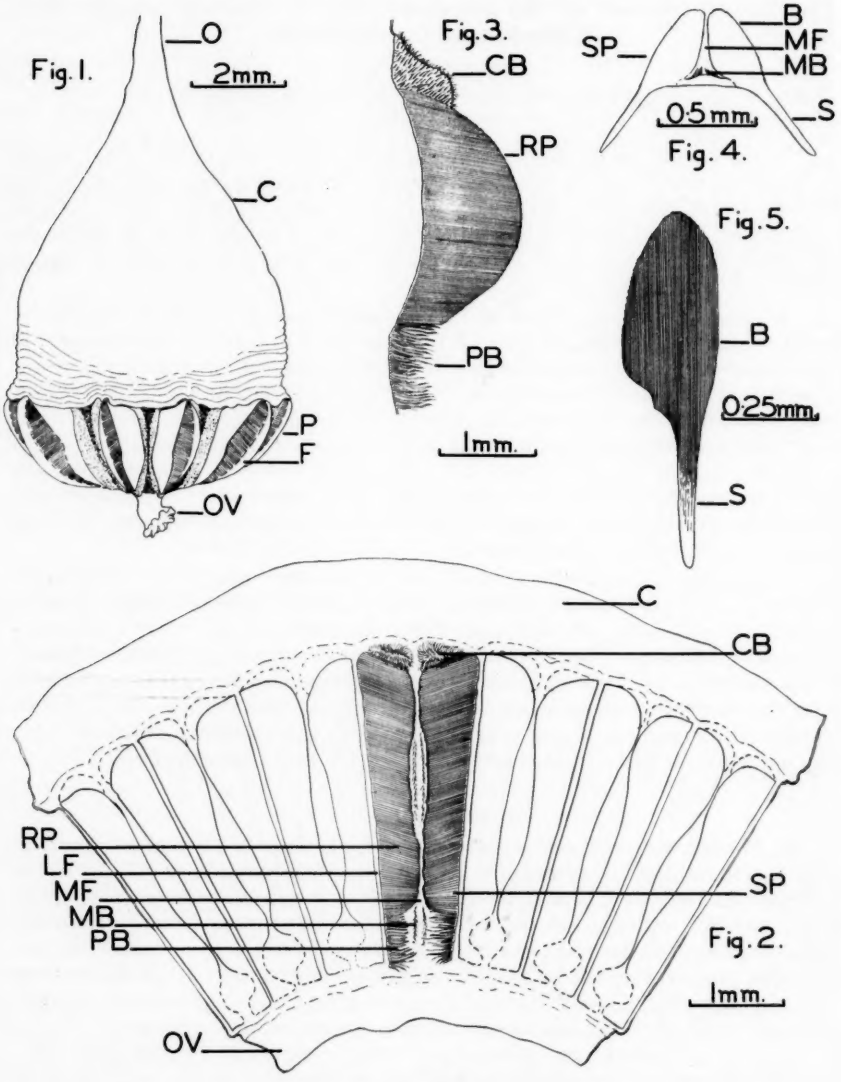

Fig. 1—Foregut devoid of muscle
Fig. 2—Flattened lining of proventriculus showing seven of the double rows of plates
Fig. 3—Lateral view of a row of plates
Fig. 4—Transverse section of two rows of plates
Fig. 5—Surface view of a sieve plate showing the fine striations

B—blade of sieve plate; C—crop; CB—cushion of bristles; F—external fold of proventriculus; LF—longitudinal furrow; MB—median bristles; MF—median furrow; O—oesophagus; OV—oesophageal valve; P—proventriculus; PB—posterior bristles; RP—row of sieve plates; S—shank of sieve plate; SP—sieve plate.

plates in a row and they lie closely appressed to one another and occupy most of the length of the row of plates. At the posterior end of a row, the plates are replaced by irregular posterior bristles (PB). A lateral view of a row of plates (Fig. 3) shows the cushion of bristles (CB) at its anterior end and the series of posterior bristles (PB) at its posterior end. The sieve plates are shortest at the anterior and posterior ends of the row and increase gradually in length toward the middle of the row, giving the inner border of the row of plates a rounded contour. A transverse section of two rows of plates (Fig. 4), at the middle of the row, shows the opposing sieve plates (SP) narrowly separated by the median furrow (MF). In the furrow are the median bristles (MB). Each sieve plate is about 1 mm. long and consists of a broad terminal blade (B) and a narrow shank (S). Each sieve plate is traversed along its length by fine striations (Fig. 5). In the intact proventriculus the blades of the plates are closely appressed to one another but are free while the shanks are attached to one another along their lengths and must be teased apart with needles in order to be separated.

Discussion

The basic structure of the proventriculus in *Entimus nobilis* is the same as that found in other weevils studied by various authors. In all species which have been studied there are the sixteen rows of sieve plates occupying the inner wall of the proventriculus, the rows being grouped in pairs which are separated from one another by longitudinal furrows. Each pair of plates is called a "Kauapparat" by Lindemann (1876), Muller (1928) and Nusslin (1911). Tissot (1938) studied the digestive tract of the white-fringed beetle, *Naupactus leucoloma* and stated that the "plates are arranged in eight pairs corresponding to the eight sections of the circular muscle". Ting (1933) called the proventriculus of weevils a "gastric mill" and noted "several rows of large, flat spines so closely set that they form ridges":

Detailed studies of the armature of the proventriculus of the grain weevil *Calandra granaria* have been made by Muller (1928) and Dennell (1942) and of *C. oryzae* by Murray and Tiegs (1935). The anatomy of the proventriculus in these two species is the same but it differs in two respects from that in *Entimus nobilis*. In *Calandra* a cluster of spines projects backward from the cushion of bristles at the anterior end of the rows of plates and extends about half-way along the length of the rows. This cluster of spines is not present in *Entimus*. Dennell (1942) and Murray and Tiegs (1935) found 60 sieve plates in a row in *Calandra*, whereas in *Entimus* there are about 150. This difference in number is probably due to the fact that *Entimus* is considerably larger than *C. oryzae* and *C. granaria*.

The variations in the structure of the proventricular armature have been used by authors as a basis for classifying the families and genera and, in some cases, the species of the beetles of the sub-order Rhynchophora. Lindemann (1876) considered that there were twelve families in this group, including the Curculionidae, and he constructed a key to separate the families on the basis of the structure of the proventriculus or "Kaumagen". The two large families of the Rhynchophora, the Scolytidae (bark beetles) and the Curculionidae (weevils) are easily distinguishable, in Lindemann's key, because each double row of plates (Kauapparat) in the Scolytidae is composed of an anterior part (Kauplatte) and a posterior part (Kaulade) while in the Curculionidae the double row of plates is uniform throughout its length. Subsequent descriptions of the proventriculus of bark bettles by other authors show that there are the two parts in each "Kauapparat": Lindemann (1877, 1879), Nusslin (1910, 1911), Felt (1906), Beal (1927), Schedl (1931), Kaston (1936) and Eaton (1942). The latter three

authors refer to the Kauplatte as the "anterior plate" and the Kaulade as the "posterior plate". All descriptions showing details of the lining of the proventriculus in the Curculionidae indicate that each double row of plates is uniform throughout its length, as claimed by Lindemann: Nusslin (1911), Muller (1928), Murray and Tiegs (1935) and Dennell (1942). This is true also of *Entimus nobilis*, for the rows of sieve plates show no suggestion of a grouping into two parts along their length.

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The Male of *Ixodes soricis* Gregson (Acarina: Ixodidae)[1]

By J. D. GREGSON[2] AND G. M. KOHLS[3]

The male of *Ixodes soricis* Gregson was discovered at Silver Creek, British Columbia, in 1948 (Gregson, 1949). The tick was found with its hypostome fully inserted into the lateral body wall of a partially engorged female of the same species. It was not described because the specimen *in situ* represented an interesting example of either accidental parasitism (Anastos, 1948), or more likely an unsuccessful attempt at copulation, since it is questionable whether the males, like those of some other species of *Ixodes*, ever feed. The recent discovery, however, by the junior author, of another specimen, in a collection of ticks from a shrew taken at Seattle, Washington, permits the following description of the male of this species.

Body.—Length, 0.97 mm. (to tip of scapula); width, 0.64 mm. Subelliptical, slightly broader behind the middle. Scutum and basis capituli yellow-brown with palpi and legs paler.

Capitulum.—Width at posterior margin of basis capituli, 0.11 mm. Basis capituli with sides converging posteriorly. Surface of basis flat, impunctate, faintly crazed, and hairless. Cornua absent. Palpi short, broad, and rounded apically, widest slightly anterior to middles; surface smooth. Sutural line between articles 2 and 3 faint, their combined length, 0.12 mm.; width, 0.07 mm.

Ventrally, basis broad, short, and nearly flat; sides straight, tapering and rounded posteriorly. Auriculae absent.

Hypostome.—Length about 0.07 mm. Apex very mildly notched; corona bearing minute, anteriorly directed processes. Denticles in about four transverse rows with three crenulations on each side of median line.

Scutum.—Convex, slightly broader posteriorly. Surface smooth and faintly crazed. Cervical grooves indistinct or absent. Lateral groove prominent, with elevated lateral fold. Scapulae rounded. Hairs sparse and confined to anterior portion.

Legs.—Coxae similar to those of the female. Coxa I with internal spur short and rounded, about half its length overlapping coxa II; external spur smaller, rounded, and about equal in size to those on coxae II and III. Length of tarsus I, about 0.26 mm.; metatarsus, 0.11 mm. Length of tarsus IV, about 0.22 mm.; metatarsus, 0.12 mm.

Spiracular plate.—Subcircular; macula slightly anterior to centre. Size, about 0.12 mm. x 0.10 mm. Boblets few and relatively large.

Ventral plates.—Median plate longer than anal plate, the latter with its lateral sides diverging slightly posteriorly. Outer sides of adanal plates nearly parallel.

Genital Aperture.—Placed on the level of the anterior margins of coxae III.

The specimen on which this description is based (28190, Rocky Mountain Laboratory) was collected with three females and two nymphs from a shrew, *Sorex vagrans vagrans* Baird, at Seattle, Washington, on December 13, 1950, by Dr. M. A. Holmes of the Washington State Department of Health. It has been deposited in the Canadian National Collection at Ottawa. The remaining male, collected on March 29, 1948, from *Sorex obscurus setosus* Elliott at Silver Creek, British Columbia, has been forwarded to the Rocky Mountain Laboratory, Hamilton, Montana.

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[3]Senior Sanitarian, Rocky Mountain Laboratory, Hamilton, Montana.

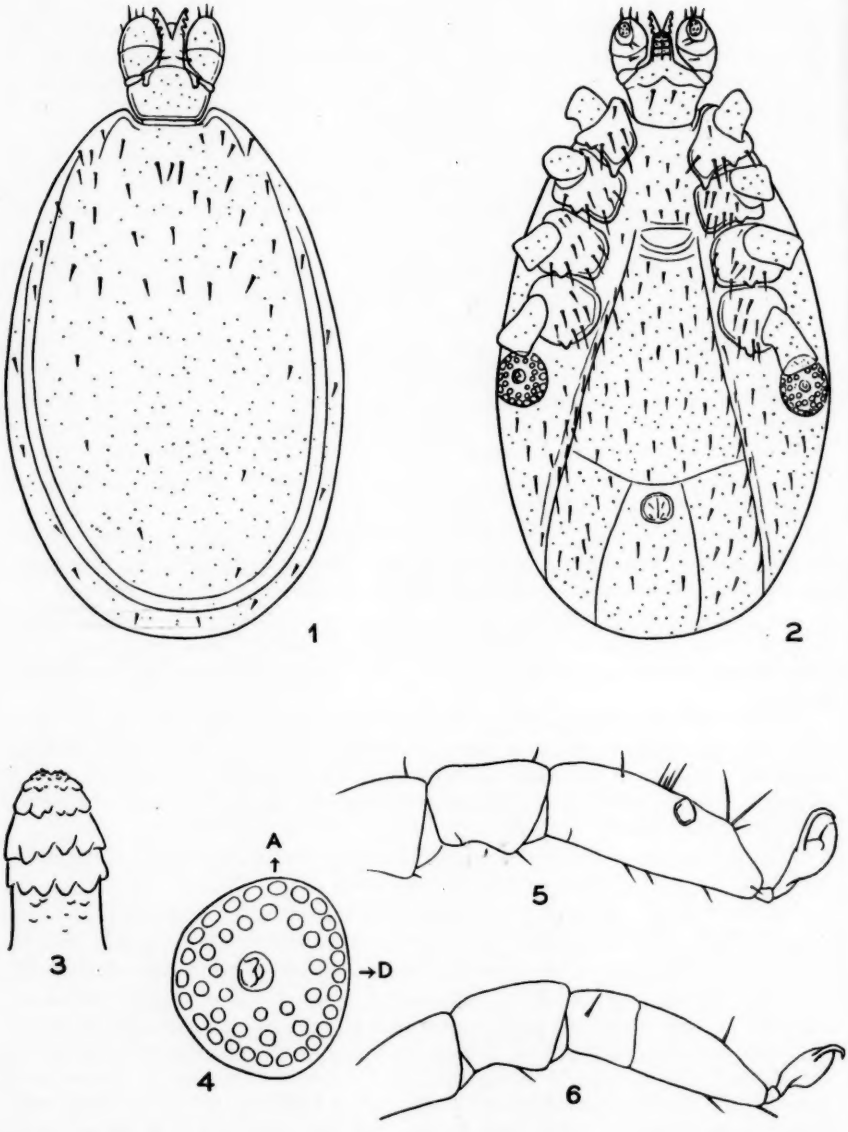

Fig. 1. *Ixodes soricis* Gregson. Male. 1. Dorsal view. 2. Ventral view. 3. Hypostome. 4. Spiracular plate. 5. Metatarsus and tarsus, leg I. 6. Metatarsus and tarsus, leg IV.

With the exception of *I. peromysci* Augustson, the male of which is comparable in size, *I. soricis* is distinguished from the males of all other North American species of the genus by its extremely small size. Except for its much smaller spiracular plates and its occurrence in the west rather than the east, it would key to *I. muris* Bishopp and Smith in the Cooley and Kohls (1945) monograph. The hypostomes of the two species are also very different, that of *I. muris* being rather deeply notched apically and with the denticles in about eight transverse rows instead of about four as in *I. soricis*.

LOCALITY RECORDS

Accession No.	Province or State	Locality	Date	Host	Number and sex or Stage	Collector
237	British Columbia	Powell River	19.VIII.29	*Sorex* sp.	2 ♀	Racey
714	" "	N. Vancouver	—.II.29	*Sorex v. vagrans* Baird	1 ♀	"
204	" "	Aldergrove	24.VIII.30	" " "	1 ♀	"
717	" "	Alta Lake	9.VIII.32	" *obscurus setosus* Elliot	1 ♀	"
1935	" "	Comox, V. I.	14.XII.39	*Sorex* sp.	1 ♀	—
2170	" "	Silver Creek	26.IV.42	" "	1 ♀	—
2177	" "	Copper Creek	8.V.49	" "	1N	—
3621	" "	Quatsino	24.V.149	" "	1 ♀	—
3626	" "	Nanaimo	7.VIII.44	" "	1 ♀ 1 ♀	— —
23572 RML	Washington	Tacoma	17.11.47	*Sorex v. vagrans* Baird	3 ♀	M. Johnson
24322 RML	"	"	—.V.47	*Thomomys talpoides* ssp.	3 ♀	"
24910 RML	"	Seattle	19.II.39	*Sorex v. vagrans* Baird	1 ♀	H. Broadbrooke
26669 RML	"	Copalis	23.VIII.48	*Sorex trowbridgii* Baird	1 ♀	M. Johnson
26670 RML	"	"	23.VIII.48	*Sorex obscurus* ssp.	1 ♀	"
26672 RML	"	Long Beach	23.VIII.48	" " "	2 ♀	"
27718 RML	"	Hurricane Ridge	12.VIII.50	*Sorex obscurus setosus* Elliot	6 ♀	"
28443 RML	"	Oakville	23.IX.50	*Sorex v. vagrans* Baird	1 ♀	B. Locker
28844-45	Oregon	Portland	28.IX.50	*Sorex v. vagrans* Baird	4 ♀ 1N	B. Locker
28446 RML	"	"	11.X.50	" " "	1 ♀	"
28447 RML	"	"	28.XI.50	" " "	1 ♀	"
28448 RML	"	"	24.I.51	" " "	4 ♀	"
20141 RML	California	Camp Mendell	10.X.42	*Sorex trowbridgii* Baird	1 ♀	R. Holdenried
20530 RML	"	Fort Baker	29.VI.43	*Sorex* sp.	7N	"
28 records RML	"	Plumas Co.	31.X.48. to to 3.V.50	*Sorex trowbridgii* Baird	29 ♀ 18N, 15L	R. Jameson
——	Colorado	Idaho Springs	—	*Sorex cinereus* ssp.	2 ♀	"

The type female of this species was taken from a shrew at Harrison Bay, British Columbia, September 3, 1940 (Kamloops file No. 1929). Since its original description by Gregson (1942), the distribution of this tick has been found to extend over much of the Pacific coast. The following selected locality records are contributed by the authors and by Jameson (1946).

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